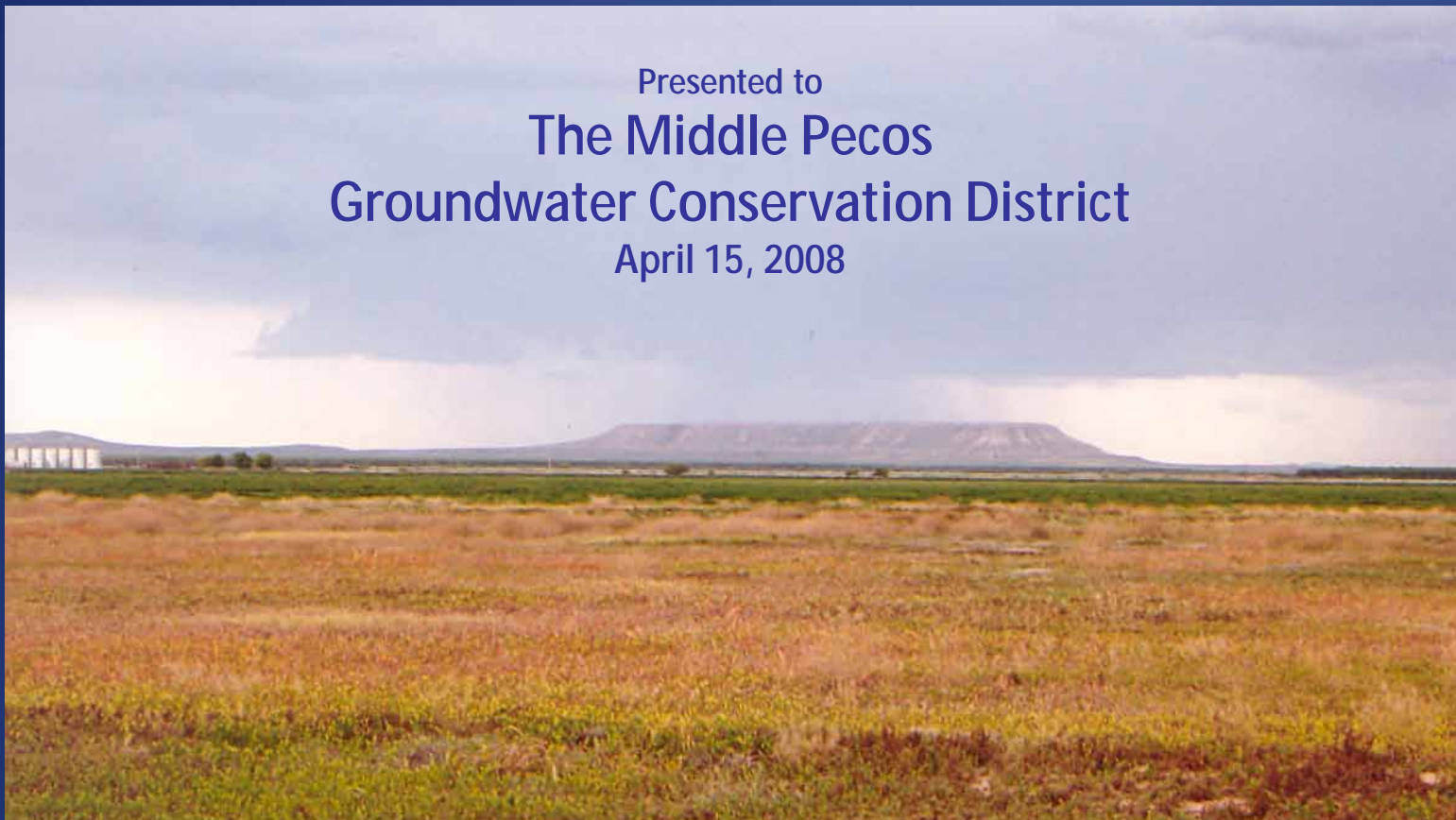


Edwards-Trinity Aquifer Study Leon-Belding Area Southwestern Pecos County, Texas

Presented to
The Middle Pecos
Groundwater Conservation District
April 15, 2008



Purposes of the Study – From the Start

- Ø Obtain updated information regarding aquifer and well conditions
- Ø Compile available data and information into useable and dynamic formats
- Ø *Assess long-term, ground-water conditions in the local Edwards-Trinity aquifer under various pumping scenarios*

Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Objectives of the Study – From the Start

- Ø Assemble information and present regional and local hydrogeologic setting, hydrologic properties and ground-water conditions
 - ✓ Geology, hydrologic units, hydraulic parameters, aquifer storage, recharge, discharge
- Ø Assess well conditions and potential yields under various water-level conditions
 - ✓ Specific capacities, well yields, spatial and temporal trends, water quality
- Ø Assess ground-water conditions with respect to Historic and Existing Use Permit pumping amounts and other pumping scenarios
 - ✓ Estimate long-term conditions with projected pumping
 - ✓ Evaluate impacts of drought
- Ø Compile a comprehensive and dynamic database
 - ✓ GIS formats, dynamic maps, cross sections, charts, diagrams
- Ø Identify additional data needs and recommend programs

Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Study Area – From the Start

Focused on the Edwards-Trinity aquifer in Leon-Belding area...



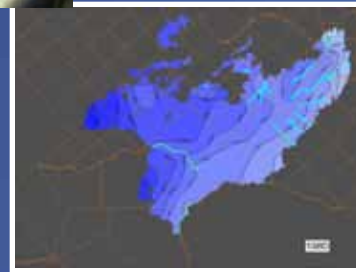
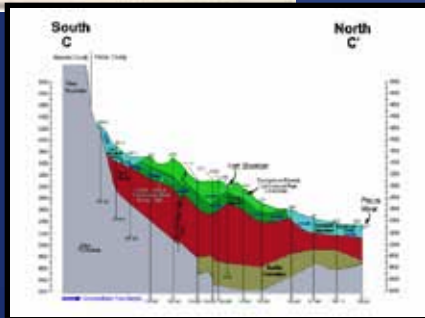
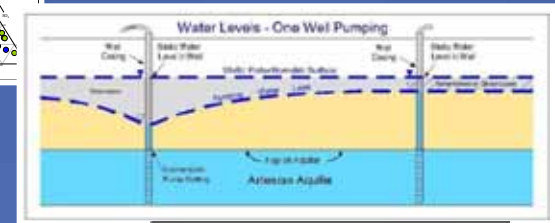
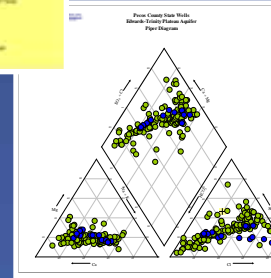
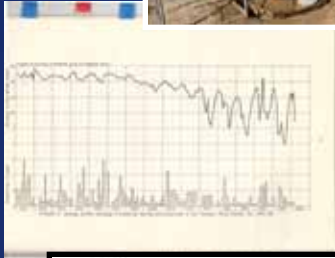
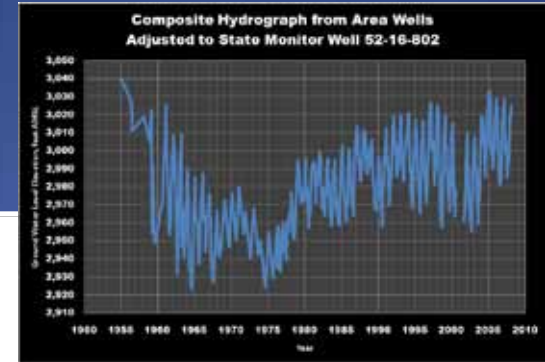
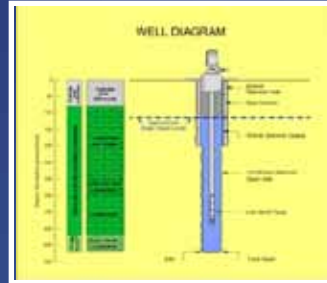
...and includes hydrologically interacting areas and aquifers

Edwards-Trinity Aquifer Study

Leon-Belding Area

Southwestern Pecos County, Texas

Work Conducted – The Water Study

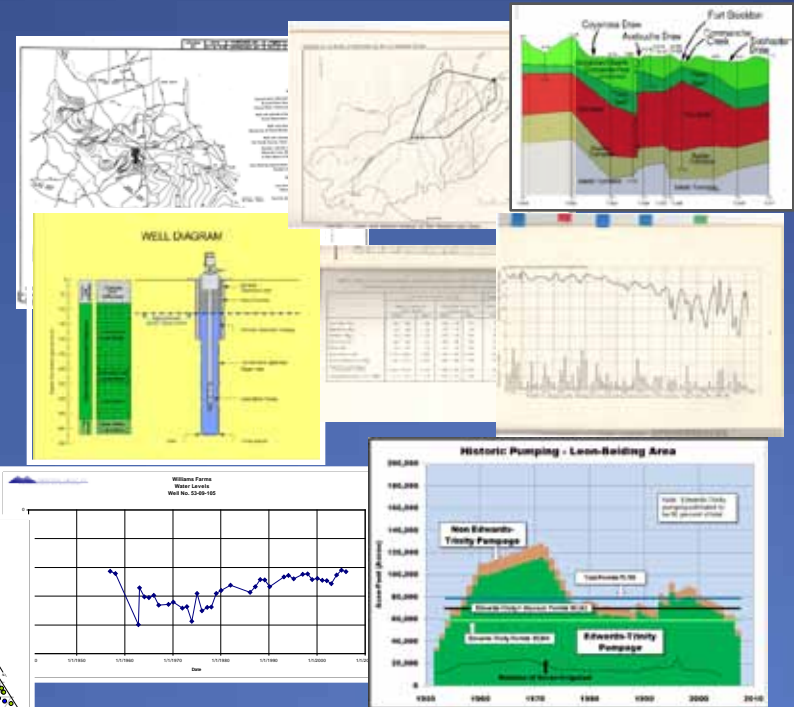


Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Work Conducted – Background Studies

Ø Compiled information from MANY previous studies and datasets

- ✓ Geology and hydrology reports
- ✓ Maps and cross sections
- ✓ Well information
- ✓ Pumping and spring flows
- ✓ Water levels
- ✓ Water quality
- ✓ Climate and soils



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Work Conducted – Remote Sensing

- Ø Aerial photography and enhanced satellite imagery
 - √ Land use for accurate irrigation estimates
 - √ Lineament study – faults and fracture trends
 - √ Other potentially important areas and features

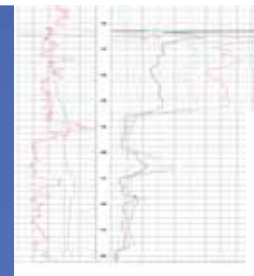
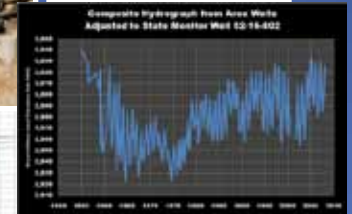
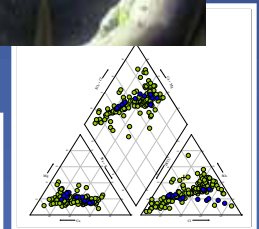
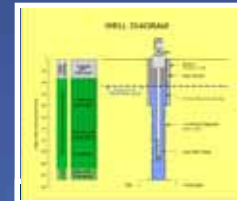


Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Work Conducted – Field Programs

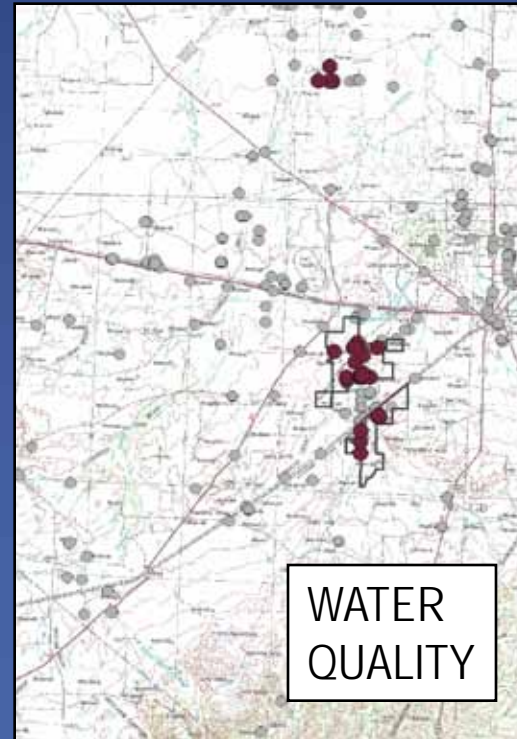
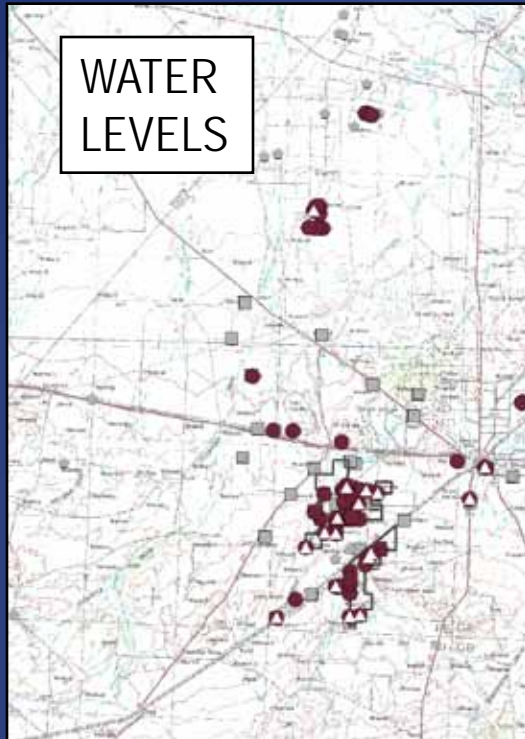
Ø Logging, testing, monitoring and sampling

- ✓ More than 100 fieldwork days
- ✓ Log and downhole video for 9 wells
- ✓ Pumping tests for 25 wells
- ✓ Pumping records – meters, daily tally, and power records
- ✓ Water levels in 41 wells for 14 months
- ✓ Continuous Recorders in 13 wells
- ✓ Sampled 29 wells – seasonal sampling
- ✓ Precipitation gauges



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Leon-Belding Area
Southwestern Pecos County, Texas

Field Programs - Locations



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Leon-Belding Area
Southwestern Pecos County, Texas

Work Conducted – Workup and Assessments

Ø Aquifer Properties and Ground-Water Conditions

√ Work Products

- ü Database

- ü Maps and cross sections

- ü Charts, graphs, diagrams and tables

√ Hydrologic calculations and estimations

- ü Historical pumping and discharge

- ü Well field production

- ü Recharge, inflows and ground-water movement



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Work Conducted – Ground-Water Modeling

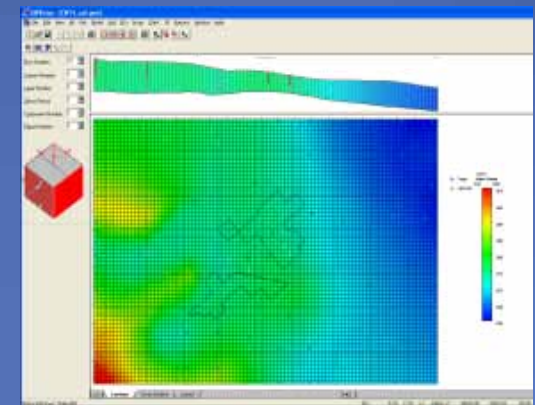
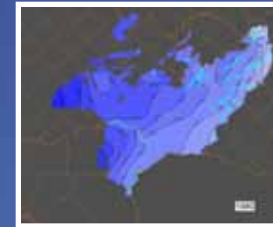
Ø Ground-Water Flow or “Availability” Modeling

√ TWDB GAM

- ü Reviewed GAM reports
- ü Ran GAM and evaluated

√ Created Model and Ran Simulations

- ü Model based on realistic geologic structure and geometry
- ü Local module that fits in regional setting
- ü Representative production distribution
- ü Calibrated to local historical records
- 1980 to Present



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Ground-Water Supply Factors (*As a Reminder*)

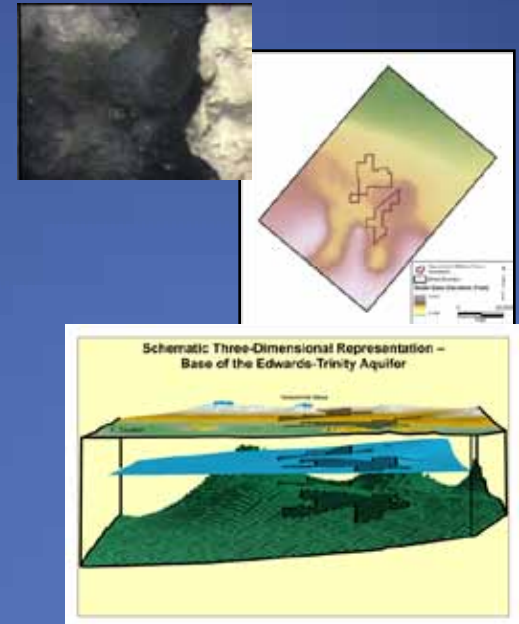
- Ø Geologic character and geometry of geologic units
 - ∨ Rock type, confining units, faults and boundaries
- Ø Hydrologic and hydraulic characteristics
 - ∨ Porosity, hydraulic conductivity, transmissivity, storage
- Ø Sources, amount, timing and distribution of recharge
- Ø Amount, location and duration of discharge
 - ∨ Natural – springs, streams, underflow, leakage, ET
 - ∨ Pumping
- Ø Quality of water
- Ø Hydrologic effects (and regulation)

Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Results Highlights – Geology

Ø Geologic Controls in the Edwards-Trinity Aquifer

- √ Karst limestone overlies “Trinity Sands”
 - ü Two components of flow and production
- √ “Troughs” and other structure
 - ü Two converging troughs feed Leon-Belding
 - ü Units get thicker, deeper in troughs
 - ü Faults and fractures enhance flow
- √ Geology defines production areas
 - ü Leon-Belding is highly productive area

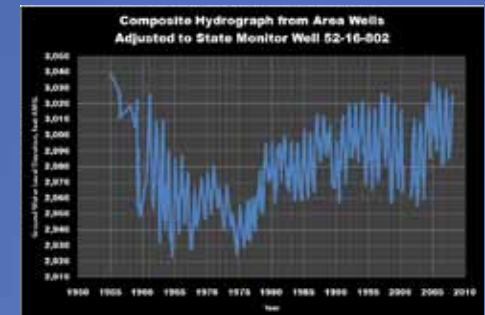


Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Results Highlights – Water Levels

Ø Illustrate Hydrologic System

- ✓ Pumping and rapid recovery
- ✓ Overall recovery since 1970's
 - ü Current water levels high (see 1950's)
- ✓ Water-level fluctuations in key wells
 - ü 70 to 80 ft in '50's and '60's
 - ü 20 to 30 ft in '70's and '80's
 - ü 50 to 60 ft during 2000-2005
 - ü 40 to 50 ft recently
- ✓ Gradient illustrates productivity
- ✓ Gradient changes with pumping
 - ü Inflows/outflows change with gradient



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Results Highlights – Historical Pumping

Ø Past Pumping is MUCH Greater than Current

✓ State estimates are low (2.5 to 3.5 feet/acre)

✓ County-wide reduction from 1960's

 ü Historical high >335,000 acre-feet per year

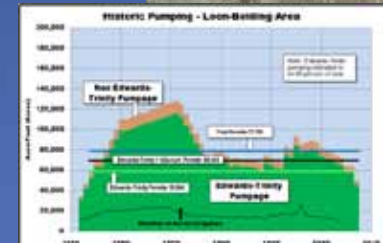
 ü Currently about 75,000 acre-feet per year

✓ Leon Belding area – Edwards-Trinity

 ü High was 100,000 to 120,000 acre-feet per year

 ü Almost 60,000 acre-feet per year (2005)

✓ Greater than H/E Use Permits

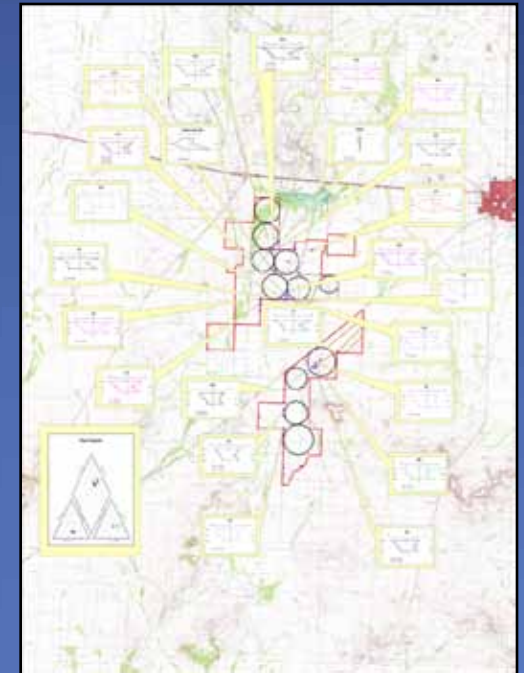
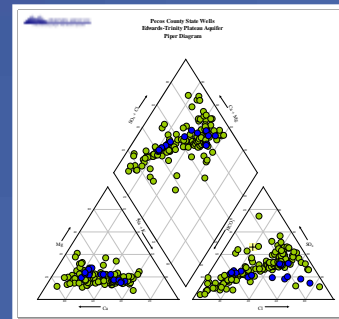


Edwards-Trinity Aquifer Study
Leon-Belding Area
Pecos County, Texas

Results Highlights – Water Quality

Ø Quality Varies Spatially and Temporally, Leon-Belding

- ✓ TDS ranges from 1,140 to 3,040 mg/l
- ✓ Small seasonal fluctuations
- ✓ Water quality and studies show water comes from big area and far away; and moves relatively fast
- ✓ May show more contribution from Trinity and/or Rustler



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Results Highlights – Inflows and Outflows

Ø Enough Water Captured to Support Historic Pumping

- ✓ Recharge – virtually none occurs locally
 - ü Much comes from mountain runoff
 - ü Large drainage areas funneled in
- ✓ Underflow or lateral inflow
- ✓ Leon-Belding is high permeability “sink”
- ✓ Pumping expands contribution area
- ✓ Bends flow paths to pumping
- ✓ Captured underflow
 - ü Prevents waste of water (quality deterioration)
- ✓ Change in storage is small portion
- ✓ Vertical leakage may be significant



Edwards-Trinity Aquifer Study

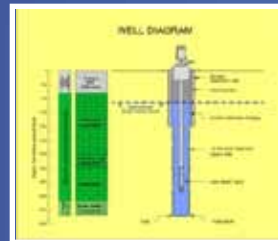
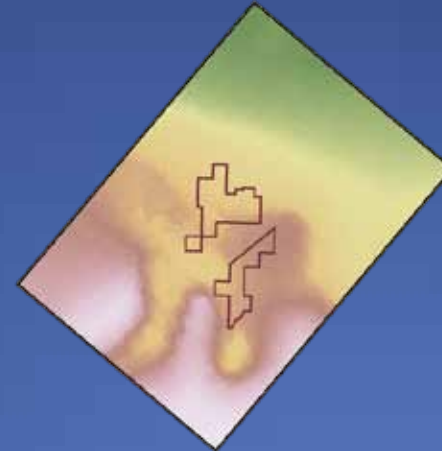
Leon-Belding Area

Southwestern Pecos County, Texas

Results Highlights – Well Capacities

Ø Hydrogeologic Setting Determines Well Characteristics

- √ Edwards vs. Trinity vs. Alluvium
- √ Troughs vs. subterranean highlands
 - ü Yields higher in troughs
 - ü Yields consistent in troughs
- √ Best wells have cracks/caverns
 - ü Rates 1,000 to 3,000 gpm
 - ü Specific Capacities 30 to 300 gpm/ft

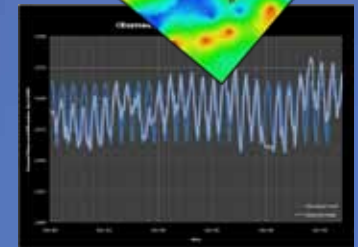
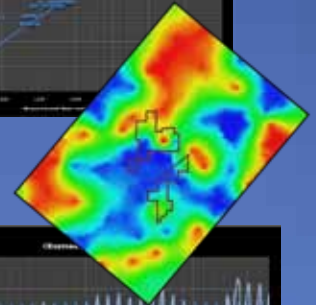
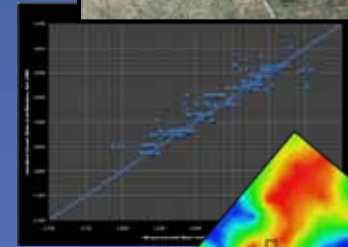


Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Results Highlights – Ground-Water Modeling

Ø Model Calibrated to Historic Conditions

- ✓ GAM does not represent the area very well
- ✓ Built a model to represent local conditions
- ✓ Model results reflect available data
 - ü Good correlation between measured and simulated water levels
 - ü Significant inflows from the south and southwest
 - ü Preferential flow towards Leon-Belding area
- ✓ Pumping at Historic/Estimated Use Permit Amounts
 - ü Shows more can be pumped



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

KEY FINDINGS – GOOD DATA BASIS

Ø Data Provide Good Groundwork for Evaluations

√ Ground-water users should support

District's monitoring efforts

- ü Will allow district to manage and eventually predict conditions more effectively
- ü Especially pumping, water levels, specific capacity and water quality

√ Other Recommendations

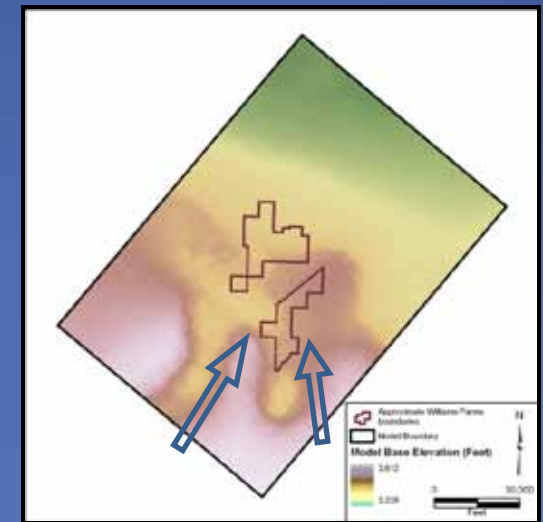
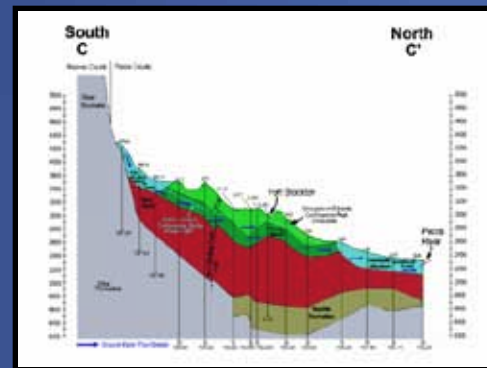
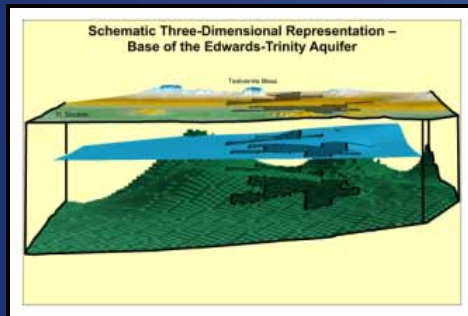
- ü Verify aquifers for each permit
- ü Use **CAUTION** with **DFC's/MAG**



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

KEY FINDINGS – HYDROGEOLOGY IS THE KEY

- ∅ Controls ground-water conditions, pumping distributions and water quality
 - √ Unique geologic and hydrologic conditions converge in the Leon-Belding area; also dictate other areas
 - √ Water funneled to prolific production area
 - √ Rainfall not major controlling factor



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KEY FINDINGS – PAST AND FUTURE PUMPING

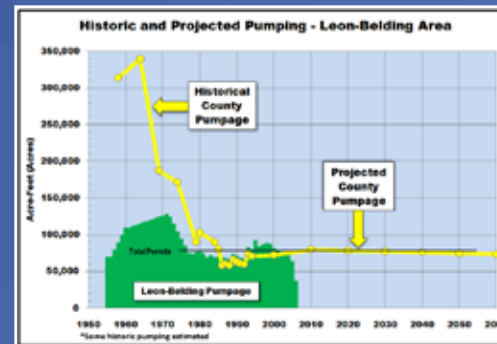
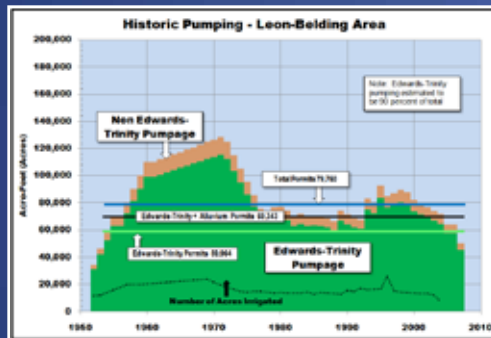
Ø Past pumping is greater than permitted and future pumping

√ Historic reductions -

ü May be due to aquifer in some areas – NOT Leon-Belding

ü Due to economics

√ Future projections show no significant increase



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

KEY FINDINGS – CAN SUSTAIN PERMITS

Ø Can pump H/E Use Permits and More -

✓ Especially in Leon-Belding area

✓ Evidence

ü Previous studies and
MPGCD Management Plan

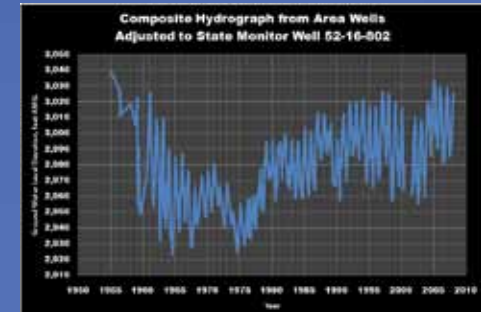
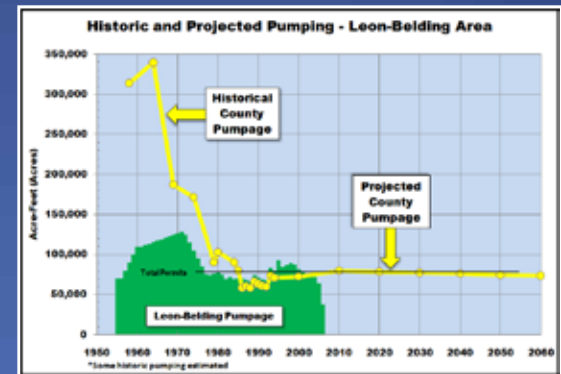
ü Recharge and other inflows

ü Historic pumping and water levels

ü Ground-water flow modeling

ü Drought not primary influence

✓ Pumping at H/E Use rates allows for
safety factor amounting to several tens
of thousands of acre-feet per year



Edwards-Trinity Aquifer Study
Leon-Belding Area
Southwestern Pecos County, Texas

Concluding Thought - The Water Study

- Ø While this study involves a complex ground-water system, the conclusions (i.e., answers) are really straightforward
 - ✓ BACKGROUND STUDIES and FIELD WORK allowed for verification, validation and working within historic knowns
 - ✓ Information available reduced the need to rely heavily on theoretical concepts and allowed for minimizing assumptions
 - ✓ Highest pumping and drought of record will likely never happen again

Ø “The Past is the key to the Future”



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Southwestern Pecos County, Texas

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